CERTIFICATION

I, Kenji Makishima of 36-404, Komayose, 5683-7, Ohba, Fujisawa-city, Kanagawa-pref, Japan, am the translator of the attached document in respect of Invention Report No. 99003596 proposed on March 30, 1999 and associated document and state that it is a true and correct translation to the best of my knowledge and belief.

Signature of the translator : Kenji Makishima

Date: June 25, 2003

Proposed date March 30, 1999

Title of the Invention: Glass-less 3D display apparatus by infrared image detection of head

Abstract of the Invention : In a transmissive display apparatus of a liquid crystal type and the like, a head image irradiated by a infrared LED is focused on a pair of photo detectors mounted at a backlight side having a space there-between by reversely utilizing the Fresnel lens for condensing the backlight separately to left and right eyes. A head tracking type glass-less 3D display apparatus wherein, respective output due to movement of the head image is supplied to a differential amplifier, and the boundary of the backlight is moved so that each other's outputs become the same level.

	Research Center	092531 satoh@devd.crl.sony.co.jp	Sato Seiji
Added	Research Center, Liquid Crystal Research Gp	100116 ogasah@src.sony.co.jp	Ogasawara Hidehiko

Related proposal
OPH7-20274

Request for foreign filing

Emphasis on handling (NS) Yes, Simultaneously

Comments: This possibly becomes an important patent, and hope to be effectively patented. FSL General Manager Mr. Watanabe

Received number
99003596

[Points of the Invention]

[Claim 1] A liquid crystal display apparatus characterized by comprising:

a pair of backlights being located apart from a back face of a liquid crystal display element, provided for right and left eyes, and having different polarizing angles to each other; and

optical means for directing the backlights separately to the left eye and the right eye after the backlights irradiate an entire display apparatus uniformly; wherein

video information of upper and lower lines are distributed to the left and the right eyes by polarizing filters being formed to be appressed to pixels of the liquid crystal display elements.

[Claim 2] The liquid crystal display apparatus as described in Claim 1, wherein

polarization of said pair of the backlights is one of a linearly polarized light and a circularly polarized light.

[Claim 3] The liquid crystal display apparatus as described in Claim 1, wherein

said optical means includes a combination of a convex lens, a Fresnel convex lens, a cylindrical concave lens, an aspherical mirror or the like.

[Claim 4] The liquid crystal display apparatus as described in Claim 1, characterized in that:

said Fresnel convex lens located on the back face of the liquid crystal display element is constructed so that an adequate space which does not cause to generate an interference fringes (moiré) of a liquid crystal pixel grid can be taken.

[Claim 5] The liquid crystal display apparatus as described in Claim 1, characterized in that:

said polarizing filter is formed to be appressed a backlight incident side of the pixels of the liquid crystal display element.

[Claim 6] The liquid crystal display apparatus as described in Claim 1, characterized in that:

said polarizing filter is provided with a $1/2\lambda$ retarder on a linear polarizing plate of the backlight incident side at every other horizontal line.

[Claim 7] The liquid crystal display apparatus as described in Claim 1, characterized in that:

said polarizing filter is provided with a photo active layer (molecule causing

molecular orientation by a linearly polarized light) on a substrate of the backlight incident side, linear polarized lights having different polarizing angles at every horizontal line are irradiated; and

after that, a layer including a dichroic molecule is applied.

[Claim 8] The liquid crystal display apparatus as described in Claim 1, characterized in that:

said polarizing filter is applied with a cholesteric liquid crystal layer having different twistings at every horizontal line on a 1/4 λ retarder of the backlight incident side.

[Claim 9] In a transmissive liquid crystal display element having optical means for focusing and directing backlight provided apart from the back to the eyes,

a head tracking type liquid crystal display apparatus focuses the head image irradiated by an infrared ray from a viewer side on the backside by utilizing said optical means; and

detects position of the head based on the position of the focused image.

[Claim 10] The head tracking type liquid crystal display apparatus constructed as described in Claim 9, wherein

a pair of photo detectors are provided apart from each other by the width of the head image on a moving boundary of the polarizing angles orthogonal to each other;

a differential amplifier is operated so that the output differences of the photo detectors by the movement of the head image becomes always zero; and

a moving object is driven by a motor so that those three, namely, a center of eyes of a viewer, a center of the liquid crystal display element, and the boundary of the polarizing angles orthogonal to each other are aligned always approximately in line.

[Claim 11] The head tracking type liquid crystal display apparatus constructed as described in Claim 9, wherein

voltage controllable polarizing elements are provided on the backlight surface in a striped form;

the boundary of the polarizing angles being orthogonal to each other is moved depending on the position of the head image by the photo detectors; and

the same effect similar to Claim 10 is obtained.

[Claim 12] In a transmissive liquid crystal display element having optical means for

condensing and directing the backlight provided apart from the back face to the eyes,

a head tracking type liquid crystal display apparatus focuses the head image irradiated by an infrared ray from a viewer side on the backside by utilizing said optical means;

detects position of the head based on the position of the focused image, and

switches .displaying video corresponding not only detection in the right and the left directions but also movement of a position in the up and down directions.

[Prior Art]

In realizing a 3-dimentional image viewing using a pair of 2-dimentional images having parallax there-between, there have been proposed various systems using a method for separately proposing to a left eye and a right eye. A system wherein a viewer wears special glasses (shutter-glasses, polarizing glasses, and the like) has a freedom in a head position, but it is not avoidable for the viewer to feel strange in wearing a foreign object. On the other hand, a 3D display apparatus of a lenticular lens system or a parallax barrier system without any glasses is already in the stage of a practical application. A backlight dividing system by a polarization (refer to the Japanese Laid-Open Patent Publication H-10-63199) proposed by the present inventors is also the latter system. Any of these systems has merit in getting freed from these glasses, but a stereoscopic viewing area is extremely narrow such as ± several cm in the lateral direction, so that a viewer is always limited his/her head position, and feels pain more than wearing glasses.

The present invention is an improved invention of the earlier filed 'Liquid Crystal Display Apparatus' (Japanese Laid-Open Patent Publication H-10-63199). Usually, as a backlight of a liquid crystal display apparatus, an area-illumination having the same area is closely provided on a back face of a liquid crystal panel, and an omni-directional light is incident into a left eye and a right eye. The liquid crystal display apparatus of the present invention utilizes a directional characteristics of convex lens having the same diameter as a display screen, and a backlight having fairly small area relative to the liquid crystal panel is respectively prepared for the left eye and the right eye at a position apart from the liquid crystal panel by a little more than a focal length of the convex lens. Now, how the small area-illumination serves as a backlight for a large area display screen is explained. Fig. 1 is a display apparatus (Patent No. 02679176) of a point source type proposed by the present inventors. A flux of light emitted from the point light source and directed to the converging lens is condensed at a certain point by a refraction of lens. If an eye is placed at the position, the entire lens is brightly brilliant, and becomes a backlight for the display screen provided around it. Fig. 2 is a plan view of a case where the point light source is replaced with an area light source for the right eye. After illuminating the entire lens brightly, the flux of light having the same components of the flux of light incident from the point light source is

incident in the right eye B. Similarly, a special light source by the area light source make a light source object image region C exist at the back. As long as the eye is placed in this region, the lens is illuminated brightly, and becomes the backlight for the display panel provided there. An optimum visible area of the respective eye by the two of the area light sources arranged at the boundary of a center axis of the lens is shown in Fig. 3.

These two of the area light sources are separated depending on the deflection angle, and directed to the left and the right eyes. A separating filter based on the polarization of light at every line is formed on the liquid crystal display screen on which stereoscopic information of the left and the right eyes is alternately proposed by a line by line basis.

The backlight is selected twice and incident to the left and the right eyes as schematically shown in Fig. 4. The backlight for the right eye having a leftward descending polarization angle is directed to the left eye by the directivity of the Fresnel lens. On the contrary, only odd-line video information for the left eye coincided with the polarization angle when selecting by the polarizing filter is incident to the left eye. Video information for the right eye is also incident to the right eye in the same way. The left and right parallax information displayed on respective odd line and even line of the liquid crystal display screen are incident on (special glasses are not necessary) only by positioning the display screen in front of the eyes, and are recognized as a stereoscopic image by a fusion in the brain. As apparent from Fig. 3, the left and right parallax information are divided at the center of the screen, so that if both eyes are entered into one of the regions by moving the head to light or left a little, it becomes impossible to carry out the stereoscopic viewing, because the same video image are incident to each eye to be a 2-dimentional image. Further, in a system where the polarizing filter is formed on a glass plate at the backlight incident side as shown in Fig. 5, video image information on the line which should not be seen is incident to the eye as a cross-talk by imposing on the primary video image information, so that the stereoscopic image becomes poor to watch. It should be noted that, since the vertical pitch of a 10.4-inch XGA (600 X 800) is 0.264 mm, the flux of light traversing the polarizing filter formed on the glass substrate of 1mm in thickness, if deviated by ± 15 degrees, utterly becomes illumination for the next line, so that the stereoscopic image

having reversed convexoconcave is to be seen. Even in the angle less than that, there is little freedom in the vertical direction due to a cross-talk. If a compensation due to the difference in sitting height or an elevation angle of the display surface in the vertical direction is not done, it causes more limitation than in the lateral direction. The present invention is performed to solve them.

[Problems to be solved by the Invention]

As methods for solving the problems, there have been proposed various technology for controlling a stereoscopic viewing area by detecting the head position and coinciding with it. If a magnet sensor is to be required on the head as means for detecting the head position of a viewer (reference 1), it is also troublesome like wearing glasses. Further, detection (reference 2) using video image of the head by a video camera cannot avoid fair cost-up. A convenient glass-less 3D display is demanded in which even a head is moved to left or right a little bit, an optimal stereoscopic image is presented to a viewer only by sitting in front of the display.

[Means for solving the Problems]

In a 3D display apparatus of a backlight separating system based on polarization proposed by the present inventors, a Fresnel lens is provided in the back face, and the backlight is incident to the left and right eyes together with the stereoscopic information by applying directivity to the backlight. Owing to the conjugation of the Fresnel lens, an infrared image of the head irradiated from the front of the display by an infrared LED or the like is focused on the backlight surface, and the stereoscopic viewing area is controlled in the lateral direction by detecting the position of the image of the head, and on the contrary, the polarizing filter is formed by closely contacting with the liquid crystal display pixels, thereby proposing a system which does not require any tracking.

[Detailed Description of the Invention]

Fig. 6 is a chart showing a principle of the present invention. A Fresnel lens (1) is essentially an optical means for directing and condensing the liquid crystal image (3) irradiated by the backlight (2) to a viewer (4). By utilizing an optical conjugation

(Namely, if another object B is put on the position of the image of an object A, the image is focused on the position of the object A) of the Fresnel lens (1), an image of a human face irradiated by the infrared LED and the like is positioned on the backlight (2) through the Fresnel lens (1), and is focused as an image (5) having a width, wherein a boundary of two polarizing plates having orthogonal polarizing angles to each other is a center. Two photo detectors (6) are mounted to be confronted on a polarizing plates with the width same as the width of the image. Outputs from the photo detectors (6) are supplied to a differential amplifier respectively after amplified and integrated. If the head moves left or right, the image thereof also swings to left or right correspondingly. At this moment, output difference occurs between two photo detectors (6). By moving the polarizing plates, on which two photo detectors (6) are confronting, with drive means such as a motor or the like, a center of the viewer (4), a center of the liquid display element, and two polarizing plates are aligned approximately in line, and the stereoscopic viewing area is to track the movement of the head.

The stereoscopic viewing area is explained with reference to Fig. 7. A light source face (10) is focused a real image as an optical image (11). Effectively, a special light source area (12) exists as a light source image area (13), and when the eyes are located on this area, the entire Fresnel lens is evenly illuminated. Similar area also exists with regard to the backlight (L), and this becomes wholly a stereoscopic viewing area as shown in Fig. 7. As apparent from Fig. 7, the area to be properly incident on respective eye is limited. In the position at front and back of the viewer, a suitable position is limited depending on a size of the display, so that it does not dislocate so large, but the position at left or right of the head of the viewer fluctuate so much, and accordingly, an automatic tracking of the head becomes necessary so that the left and right eyes are located correctly in the stereoscopic viewing area.

A specific example for carrying out is explained with reference to Fig. 8. If a suitable position for watching a screen image having 8.4 inches is 50 cm (about 4H) from a front face of the Fresnel lens, then the flat portion (12 cm) of a human face is focused at the back of 15.5 cm an image having a width of 37.2 mm. At a position of a photo detector for automatic tracking head image mounted at 14 cm back of the Fresnel lens, it becomes an image having a defocused boundary. The width of the image changes depending on the back and forth position of the head. For example, if being

apart by 75 cm, it becomes an image having a width of 22.4 mm at the position of the photo detector. Also in this case, the periphery is defocused as the human face is not flat. Then, the distance between the two photo detectors is set to 25 mm or the like. As the output of the differential amplifier is a relative difference of inputs, the existence of the defocused area acts advantageously. Fig.9 is an operational block diagram of the photo detectors moving along with the polarizing plates having polarizing angles in two directions having higher level in accordance with a level difference of the two photo detectors detecting the human face image.

Then, a mechanism for automatically tracking the head image is explained with reference to Fig. 10.

A reference sign ① shows a condition where the head image is properly focused between the two photo detectors. In this case, the differential amplifier generates outputs having the same level, so that a command signal for moving to left or right is not generated.

Next, in the condition ② where the head image is moved to left by the movement of the head, a level difference occurs between the two photo detectors. The two photo detectors are so arranged to move towards a larger level difference, accordingly, the two photo detectors move to right. By moving the pair of polarizing plates, wherein the two photo detectors are mounted and polarizing angles of them are orthogonal to each other, to right, their boundary, a center of the liquid display, and a center of the viewer's eyes are in a condition aligned in line as shown in ③, and the stereoscopic viewing area also moves. If the head moves to right, the stereoscopic viewing area moves to left by the similar operation. As means for moving the pair of polarizing plates having orthogonal polarizing angles to each other, as shown in Fig. 11, there is a method where the pair of polarizing plates are fixed to both end of a wire wound on a pulley of a motor having a reduction gear, and moved to left or right. Further there is another method called a polarizing backlight system including a pair of polarizing plates having orthogonal polarizing angles to each other, but not requiring any movable parts. This system has a construction where a voltage-controlled polarizing angle type liquid crystal is provided in a strip form as shown in Fig. 12 and the photo detectors are mounted on respective liquid crystal. For example, when the head image is focused on the photo detectors 1 to 4 as shown in Fig. 13, the boundary of

the polarizing angle by the position of the head image is possible to be moved by electrically by applying a voltage to respective variable polarization angle type liquid crystals so as to make polarization angles of right and left orthogonal to each other at A as a boundary.

By the method as described above, it is able to correspond with the movement of the head in the lateral direction. Regarding correspondence with the movement of the head in the vertical direction, if the polarization filter for separating the left and the right image lines is formed to be appressed to the pixels, the movement in the vertical direction becomes free. Next, the method for forming it is described. Figs. 14 to 16 show the embodiment for it. Fig. 14 shows a construction where a $1/2\lambda$ retarder is formed by etching at every other line on the polarizing backlight incident side of the linear polarizing plate and on the thin glass plate of 0.1 mm in thickness, then this is sandwiched by a relatively thin glasses. The $1/2\lambda$ retarder has a function to rotate the polarizing angle by 90 degrees, so that two kinds of polarizing backlights incident on upper and lower lines are separated depending on presence or absence of the retarder by the directional character. The behavior of the flux of light from the linear polarizing plate is the same as that of a conventional liquid crystal display panel. In Fig. 15, on a protective film for the transparent electrode of the backlight incident side, a substrate layer for binding or applying a photoactive molecule are provided, irradiate a linear polarizing light line by line so as to cause an orientation change of a molecule axis, and further provides a layer including a dichroic molecule thereon. It is also possible to provide a layer including a dichroic molecule so that the polarizing angles become orthogonal to each other at each line on the protective layer of the transparent electrodes of the polarizing backlight incident side, but a structure where a linear polarizing plate coinciding with one of the polarizing angle is adhered on the glass surface of the polarizing backlight incident side is more economic. In this case, the condition of the transmitted light when voltage is not applied differs at each line. Namely, there are a normal white mode and a normal black mode, so that it is necessary to drive by the normal white mode at a display area where the polarizing angles are orthogonal and by the normal black mode where the polarizing angles are the same. In Fig. 16, cholesteric liquid crystals having different flex angle line by line is applied on the $1/4\lambda$ retarder on the protective film of the color filter. The cholesteric liquid crystal is

all-reflective to a circularly-polarized light having the same direction of the helix, and transmits a circularly-polarized light having the opposite direction, and accordingly, if the backlight is polarized to the right circularly-polarized light for the right eye and the left circularly-polarized light for the left eye, it is able to be separated on the line of the liquid crystal panel. The right circularly-polarized light and the left circular polarized light passing through the cholesteric liquid crystal are converted at the 1/4 λ retarder to a linear polarizing light being orthogonal to each other. If it takes a construction where a linear polarizing plate coinciding with either one of the polarizing angles is adhered on the glass surface of the polarizing backlight incident side, the driving becomes similar to the one in Fig. 15. Not only the freedom of the head in the vertical direction is increased, but also it is possible to fabricate within the fabrication process of the liquid crystal apparatus by forming the polarizing filter to be closely contacted to the color filter as described in the above mentioned three examples.

Usually, in a stereoscopic display apparatus based on two of 2-dimentional image, when a viewer moves the head to left or right, there is a phenomenon where the image also moves depending on the movement of the viewer, because there is no rear information. This is the point having big difference when watching the stereoscopic object by naked eyes. According to the present invention, there is provided with head position detecting means for head tracking, so that it is possible to avoid an unnaturalness by switching to the previously prepared stereoscopic image viewed from right when the head moves to right, for example. This switching of the image may be synchronized with the movement of the head, but it is also possible to rapidly switch to the stereoscopic image viewed from right immediately when the head moves to right. In such a case when it is not the stereoscopic image, this is able to use to operate the screen without a mouse by carrying out the scroll operation for up, down, left, and right directions.

The glass-less stereoscopic display apparatus of the head tracking type according to the present invention, the backlight cannot be closely contacted to the liquid crystal panel in principle, and it is necessary to set apart from the focal length of the Fresnel lens, and further, it is possible to miniaturize by folding by 90 degrees at the mirror because it takes space and in convenient for carrying. It is possible to make it minimum size by taking a construction where the mirror can be folded when not in use.

If it has a construction where the Fresnel lens is set apart a bit from the liquid crystal panel in conjunction with the movement for opening the mirror when use, the moiré caused by the groove of the grid of liquid crystal panel and the Fresnel lens becomes not visible. Fig. 15 is the specific example thereof. In this embodiment mentioned above, a plane mirror is employed, but if an aspherical mirror is employed, the Fresnel lens becomes not necessary, and there is generated less moiré.

[Effect of the Invention]

1. Conventionally, the head tracking is carried out by detecting a head position of a viewer based on an image information from a CCD camera and the like, this caused cost-up. It has a simple structure such that the head image by irradiation of the infrared LED is focused on the backlight face by utilizing an optical element (Fresnel lens) provided for condensing and directing the backlight, so that the cheap infrared LED becomes a substitution of an expensive CCD camera. Accordingly, a head tracking type glass-less 3D display is realized with extremely large cost-down.

2. A precision automatic tracking is possible, because the moving object is driven so that the output difference becomes zero at the differential amplifier by detecting the head image by the infrared LED focused on the backlight face with a pair of photo detectors mounted on a moving body moving to left and right.

3. As a backlight for left eye and right eye, a pair of polarizing plates having orthogonal polarizing angles to each other is closely contacted at the backlight face, and the combination is moved to left and right, and accordingly it is possible to rapidly move by a small sized motor, and to rapidly react to the movement of the viewer.

4. In the combination where a pair of polarizing plates having orthogonal polarizing angles to each other is closely contacted, the boundary of the polarizing angle cannot be depending on a mechanical structure but be a slid state by using polarizing element a polarizing angle of which is voltage-controllable.

5. The construction becomes small by folding the backlight and the mirror, so that it is very convenient to carry.

6. The spatial separation filter for left and right images are formed closely contacted to pixels, a freedom in the vertical direction is large, and, accordingly,

it is possible to propose a perfect personal glass-less 3D display apparatus by combining with a tracking mechanism in the lateral direction.

7. As the spatial separation filter for left and right images can be formed closely contacted to pixels within a fabrication process of the liquid crystal panel, this causes a relatively large cost-down compared to a conventional externally mounting system.

A Specific Example Liquid display element : 8.4 in. transmissive color LCD (SVGA)

Optical device : f/118 mm Fresnel lens

LCD display element Fresnel lens

Head

Operational block diagram

Pre-amp. Amp./Integration.

Diff. Amp. Rev./For. Drive circuit Motor

Pre-amp. Amp./Integration.

Human face image by infrared LED

Principle of operation : Two photo detectors detected the human face image are set to be moved to a larger level by a motor. The photo detectors move together with a pair of polarizing plates having orthogonal polarizing angles to each other.

A Specific Example

Liquid display element : 8.4 in. transmissive color LCD (SVGA)
Optical device : f/118 mm Fresnel lens

LCD display element Fresnel lens

Head

If a suitable position for watching a screen image having 8.4 inches is 50 cm (about 4H), then the flat portion (12 cm) of a human face is focused at the back of 15.5 cm an image having a width of 37.2 mm. At a position of a photo detector for automatic tracking head image mounted at 14 cm back of the Fresnel lens, it becomes an image having defocused boundary. The width of the image changes depending on the back and forth position of the head. For example, if being apart by 75 cm, it becomes an image having width of 22.4 mm at the position of the photo detector. Also in this case, the periphery is defocused as the human face is not flat. Then, the distance between two photo detectors is set to 25 mm or the like. As the output of the differential amplifier is a relative difference of inputs, existence of the defocused area acts advantageously.

Operational block diagram

Pre-amp. Amp./Integration.

Diff. Amp. Rev./For. Drive circuit Motor

Pre-amp. Amp./Integration.

Human face image by infrared LED

Principle of operation : Two photo detectors detected the human face image are set to be moved to a larger level by a motor. The photo detectors move together with a pair of polarizing plates having orthogonal polarizing angles to each other.

Mr. Sato

I'm Ogasawara.

I was late for it.

Here is a description for Figs. 15 & 16 in addition to claim 7.

It became so long....but

Any way, would you please review this?

=====================================

[Claim 7] (Characterized in which said polarizing filter includes a dichroic element (molecule) layer having polarizing axis changing at every horizontal line on the substrate (backlight incident side).

[Claim 7-1] (Characterized in which said polarizing filter includes a dichroic element (molecule) layer having polarizing axis changing at every horizontal line on the substrate (backlight incident side)

[Claim 7-2] (Characterized in which said polarizing filter includes a dichroic molecule layer on the substrate (backlight incident side), wherein their orientation are induced by light.

Fig. 15 is a method which utilizes a pattered dichroic element (molecule) layer.

This is a method where there is disposed a polarizing element having orthogonal axis at every horizontal line under the transparent electrode layer formed on a substrate at incident side of the polarizing backlight. Specifically, it is realized by following method. On a substrate on which a light excitation layer is applied at the incident side of the polarizing backlight, a mask having apertures is aligned at every other line, and orientation is carried out by irradiating linearly polarized light having electric field vector to a desired polarizing direction. After that, the mask is shifted up or down by one corresponding line, the substrate is rotated by 90 degrees, and orientation layer is obtained by irradiating the linearly polarized light. If a polarizing element having orthogonal polarizing direction at every line and fabricated by the fabrication method of this substrate is used as the mask, then the orientation process is able to be carried out by a single exposure of non-polarizing light. If necessary,

stabilization of orientation may preferably carried out by heating process or the like. Anisotropism occurs in the photoactive layer by irradiation of linearly polarized light, and further it is prefer to use molecule having a liquid crystal orientation property and prefer to use molecule such as azobenzene in which orientation change of the molecule axis occurs by irradiating linearly polarized light. Further as another method, it is possible to fabricate it by providing a resin film layer having a liquid crystal orientation property, carrying out rubbing process after coating resist at every line, pealing off the resist, coating portions applied the rubbing process, and again carrying out the rubbing process after rotating the substrate by 90 degrees.

A solution of liquid crystalline dichroic molecule of the lyotropic type is applied on thus fabricated orientation layer. The dichroic dye layer has a liquid crystallinity when the solvent is still remained, and is oriented according to the lower surface. The dichroic dye layer is stabilized by dry process to be a solid or amorphous state while maintaining this orientation, and is able to serve a function as a polarizing element (ref. OP10-333154). A gray dye can be used as the dichroic molecule, but if a solution of a liquid crystalline dichroic molecule of the lyotropic type is used by coating with patterning by such as printing method, it is preferable to combine the polarizing element with the color filtering function.

Further, it may be fabricated by forming an adhesive layer of a predetermined substrate, and peeling off after being superposed and adhered to the dichroic molecule layer which is previously formed on another substrate as described above (ref. OP9-197125). Usually, a protective layer is provided on it. Although the dichroic molecule layer may be provided on the protective layer of the transparent electrodes of the opposing polarizing backlight incident side so as for the polarizing angle to be orthogonal at every line, it is more economical to take a construction where linear polarizing plate coinciding with either one of polarizing angles is adhered on a glass surface of the polarizing backlight incident side. In this case, the condition of the transmitted light when voltage is not applied differs at each line. Namely, there are a normal white mode and a normal black mode, so that it is necessary to drive by the normal white mode at a display area where the polarizing angles are orthogonal and by the normal black mode where the polarizing angles are the same.

Fig. 16. A method where a cholesteric liquid crystal having different helix directions are used as a separation film.

It is a method where only circularly polarized light of right-handed or left-handed is irradiated from backlight portion of left eye or right eye, and circularly polarizing separation element being orthogonal line by line is provided under the transparent electrode layer of the substrate of the backlight incident side.

Specifically, it is realized by following method.

The backlight portion may be formed specifically on a general luminescent source such as cooling tube by ① adhering 1/4 λ retarder on the orthogonal polarizing element, or by ② using a layer (will be described later) of a cholesteric liquid crystal of left-handed (or right-handed) for broad wavelength band.

In the cholesteric liquid crystal layer, a circularly-polarized light polarized opposite to the direction of the helix transmits, but the one polarized to the same direction selectively reflects depending on the pitch of the helix. Namely, by adjusting the wavelength corresponding to the product (herein after referred to as nd) with the reflective index of the liquid crystal by adjusting the helix pitch, it becomes possible to reflect light having all wave length in a visible region, and is able to use as a separation film and a color filter.

For example, specifically, by utilizing the fact that the pitch of the cholesteric liquid crystal is largely changed by temperature, and a temperature profile is formed by heating below the substrate, then it is able to assign a desired pitch by controlling the temperature profile with a respectively corresponding mask. If a cholesteric liquid crystal of photo polymerization type such as an acrylate monomer is employed and polymerization initiator is having a proper concentration (1 to 5 %), the condition of the pitch is stabilized by light irradiation, and selected wavelength transmission film is obtained.

The right-handed (left-handed) cholesteric liquid crystal is provided by printing or roller coating at every other line on the substrate of the backlight incident side, and a stabilized cholesteric liquid crystal layer is provided by adjusting the wavelength region

of the reflected light being even within the entire visible light region (400 to 850 nm, for example). At the one line in-between, similar left-handed (right-handed) cholesteric liquid crystal is provided. The order may be opposite, and further simultaneous. Color filter may be provided separately, but on the line of the right-handed (left-handed) helix type cholesteric liquid crystal on the substrate, it is possible to provide a cholesteric layer selectively filtering only left-handed (right-handed) red light by adjusting the helix pitch. If lines for filtering green light and blue light are sequentially provided, it is possible to combine with a color filter. And, the $\lambda/4$ retarder is formed on this. Usually, a flattened protective layer is provided on this. This is adhered to the opposed electrode by forming transparent electrode and the like.

The light for left and right eyes from the backlight is separated by this cholesteric liquid crystal layer. The right polarizing light and left polarizing light passing through the cholesteric liquid crystal layer are converted into linear polarization being orthogonal to each other by a $1/4\lambda$ retarder. It is converted to a linear polarizing light coinciding with either one of polarizing angle on the glass surface of the polarizing backlight incident side. If it takes a construction where a linear polarizing plate coinciding with either one of the polarizing angles is adhered on the above mentioned opposed substrate, namely on the glass surface of the polarizing backlight incident side, the driving becomes similar to the one in Fig. 15.